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SPECIFICATION

FOR

VIDEO GAME ARRAY

MPS 7600-001

PRELIMINARY

Preliminary - April 1976
Rev. 1 - June 1976

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1.0 PRODUCT DEFINITION

This document describes operating features and interface characteristics of the MPS 7600-001 Video Game Array (VGA). The VGA is supplied as a single chip manufactured with a standard P-channel, ion implanted MOS process and mounted in 28 pin dual-in-line plastic package.

The VGA is a programmable device. As such, the "001" version represents the first of a series of arrays based on the same chip design but programmed to perform different combinations of games with different operating features and strategies. The programming of each array in the VGA series is accomplished at the time of manufacture and is a permanent feature of the specific chip (as are the fonts of ROM's and calculator arrays with mask programmed customization).

The MPS 7600-001 VGA is programmed to play three different video "ball action" games including tennis, hockey, and handball. In addition, two target games are included. Variations of the four basic games are provided depending upon the number of players involved in the game action. A total of 8 game variations is provided.

The VGA is designed to simplify and minimize the external circuitry required for player controls, sound generation, and interface with a color or black-and-white consumer television receiver. The MPS 7600-001 is specifically designed to interface with television receivers using United States standards for scanning and color control.

2.0 PRODUCT FEATURES

2.1 Operating Features

- Games: Tennis (2 Player or 4 Player)
 Hockey (2 Player or 4 Player)
 Handball (1 Player or 2 Player)
 Target (2 Variations)
- Controls: Game Select (4 Position Rotary Switch)
 Game Variation Select
 Manual or Automatic Mode Select
 Game Reset
 Serve
 Amateur/Expert Select (Team A or Team B)
- Ball Action: 3 Ball Speeds
 5 Ball Angles (simulated paddle "english")
 Automatic Ball Speed and Angle Selection
- Scoring: Digital Scoring (2 digits per team)
- Sound: 3 Sounds (for paddle hit, boundary hit, and score).

2.2 Electrical Features

- Color or black-and-white TV
(all required timing signals supplied)
- Single power supply; broad operating tolerances
- Crystal controlled clock operation (3.58 MHz)

3.0 FUNCTIONAL DESCRIPTION

3.1 Game Description - Tennis

The game of tennis may be played with two or four players. Play will proceed either automatically or under manual control in response to the Serve button.

For all variations of Tennis, the game is played on a field consisting of a top border, a bottom border, an end border at left and right, and a center net. For the two player option, one player paddle appears at each end of the field fairly close to the end boundary. For the four player option the additional two player paddles appear on either side of the center net at a point fairly close to the net. In all cases, player controls act to move the player paddles in the vertical direction only.

Action of the two player Tennis game begins with depression of the Reset button. The initial score (00,00) appears on the screen. If automatic mode is selected, a delay occurs after which the ball is automatically served from the vicinity of one of the player paddles and proceeds across the net toward the second player. The second player attempts to intercept the ball path with his paddle. If successful, the ball rebounds from the paddle at one of five angles (See Fig. 3.6) depending upon which portion of the paddle actually intercepted the ball.

The ball will rebound from a top or bottom boundary with an angle of reflection equal to its angle of incidence.

Should either player fail to intercept the ball, the ball will proceed to the end boundary and will disappear. A new score is computed and will appear on the screen. After a delay, the ball will be served again from the vicinity of the paddle belonging to the player who has just scored.

Play will proceed in this manner until either player has scored a total of 21 points. At this time, the final score will appear on the screen and all further ball action will cease. A new game is begun by depressing the Reset button.

Operation in the Manual mode is the same except that ball service occurs only in response to a depression of the Serve button.

Operation of the four player tennis game is the same except that any of the four players may intercept the ball and return it toward the opposite end boundary. In the event that the rear player on either team returns the ball and the ball intercepts the paddle of the net player on the same team, the ball will not reflect from the net player's paddle but will continue on over the net and toward the opposite boundary.

The configuration of the tennis game is as shown in Fig. 3.1A for the two player version and Fig. 3.1B for the four player version.

Ball speed for the tennis game is varied automatically as a function of volley length. Each volley begins with the ball traveling at slow speed until three player returns have occurred. The ball will now move at medium speed until the next five player returns have occurred. Thereafter, the remainder of the volley will proceed with high ball speed until a score occurs. The shift from medium to high ball speed may be inhibited by placing the Amateur/Expert switches for either or both teams in the Amateur position. For example, placing the switch for Team A in the Amateur position means the ball will never be returned at high speed toward the left side of the playing field.

Three sounds are generated as the play proceeds. Sound 1 occurs each time the ball is reflected from a top or bottom boundary. Sound 2 is generated each time a ball is returned by a paddle hit. Sound 3 occurs each time a score is made.

3.2 Game Description - Hockey

The game of hockey may be played with two or four players. Play will proceed either automatically or under manual control in response to the Serve button.

For all variations of Hockey, the game is played on a field consisting of a top border, a bottom border, a center line, and two end borders. In each end border, an opening appears to signify the goal area.

Whether controlled by two or four players, each team consists of a "Goalie" and a "Forward". Thus, four players appear on the display at all times. The "Goalie" is located close to the goal on either side of the display. The "Forward" is located on the opposite side of the field from the goal defended by his team. For the two player option, each player control moves the "Goalie" and "Forward" for a given team together in the vertical direction only. For the four player option, each player control exercises vertical position control over one of the four players. The game proceeds with two teams each consisting of two players.

Action of the two player Hockey game begins with depression of the Reset button. The initial score (00,00) appears on the display. If automatic mode is selected, a delay occurs after which the puck is served from one "Goalie" and proceeds across the center line and toward the opposite goal. The second "Goalie" attempts to intercept the puck and prevent it from entering the defended goal area. If successful, the puck will rebound toward the opposite goal and must be intercepted by the other player. "Forwards" are used for two purposes. First, a team "Forward" may intercept and return a puck moving in the direction of his goal and redirect it toward the opposite goal. Second, the "Forward" may intercept a puck moving toward the opponents goal and redirect the puck at a different angle into the opposing goal.

The puck will rebound from top, bottom, or end boundaries at an angle of reflection equal to the angle of incidence. The puck will rebound from player shapes at one of five angles. (See Fig. 3.6) depending upon which portion of the player actually intercepts the puck.

Should the "Goalie" miss the puck and allow it to enter the goal area, the puck disappears and the updated score will appear on the screen. After a delay, the score will disappear and the puck will be served from the "Goalie" of the team obtaining the most recent score.

Play will proceed in this manner until either team has scored a total of 21 points. At this time, the final score appears on the screen and all further ball action will cease. A new game is begun by depressing the Reset button.

Fig. 3.2 shows a diagram of the hockey game with a return shot by the "Forward" and with a pass forward by the "Forward".

Ball speed for the hockey game is varied automatically as a function of play action leading up to each score. After each score, the puck will travel at slow speed until three player returns have been made. The puck will now travel at medium speed until five additional player returns are recorded. Thereafter, the puck will travel at high speed until a score is recorded. The shift from medium to high ball speed may be inhibited by placing the Amateur/Expert switches for either or both teams in the Amateur position. For example, placing the switch for Team A in the Amateur position means the ball will never be returned at high speed toward the left side of the playing field.

Three sounds are generated as the play proceeds. Sound 1 occurs each time the ball is reflected from a top, bottom, or end boundary. Sound 2 is generated each time the puck is reflected or intercepted by a player. Sound 3 occurs each time a score is made.

3.3 Game Description - Handball

The game of handball is played with either one or two players. Play proceeds either automatically or under manual control in response to the Serve button.

The game is played on a court consisting of a top and bottom border and a wall at the left end of the display. For the two player option, both players appear at the right side of the display. There is a horizontal position difference between the players so that they may never appear superimposed. Player controls act to move the players in the vertical direction only. For the single player option, only one player will appear on the display.

Action for the two player version of handball begins with the depression of the Reset button. The initial score (00,00) appears on the screen. If automatic mode is selected, a delay occurs after which the ball is automatically served from the vicinity of a player and proceeds toward the wall. The second player must intercept the path of the returning ball. If successful, the ball will rebound at one of five angles (See Fig. 3.6) depending upon which portion of the player actually intercepted the ball. Play alternates between the players. If a ball is returned by one player and the same player intercepts the path of the returning ball, the ball will pass through the player (no rebound) and the second player is still free to return the ball. Balls traveling toward the left wall will pass through either player and continue toward the wall.

The ball will rebound from the top, bottom, or end wall with an angle of reflection equal to the angle of incidence.

Should either player fail to intercept a returning ball when it is his turn to play, the ball will pass off the court to the right and will disappear. The new score is computed and appears on the display. After a delay, the ball is served again from the vicinity of the player scoring the previous point.

Play will proceed in this manner until either player has scored a total of 21 points. At this time, the final score will appear on the display and all further ball action will cease. A new game is begun by depressing the Reset button.

Operation in the Manual mode is the same except the ball service occurs only in response to a depression of the Serve button.

Operation of the single player version of handball is the same except that only one player appears on the court. In addition, the score is computed to show the number of the volley on the left and the total number of successful returns for that volley (a measure of player skill) on the right. A score of 10 22 is to be interpreted as the tenth point during which the player was successful in returning the ball 22 times.

Fig. 3.3 shows the display configuration for the handball games.

Ball speed for either version of the handball game is varied automatically as a function of volley length. Each volley begins with the ball traveling at slow speed until three player returns have occurred. The ball now travels at medium speed until an additional five player returns have occurred. Thereafter, the ball will travel at high speed until a score occurs. The shift from medium to high speed may be inhibited by placing the Amateur/Expert switches for either or both teams in the Amateur position. For single player handball, the Amateur position for Team B is used to eliminate high speed ball motion from the game. For two player handball, the Amateur position for Team A will inhibit high speed returns by the player closest to the wall and the Amateur position for Team B will inhibit high speed returns by the player furthest from the wall.

Three sounds are generated as the play proceeds. Sound 1 occurs whenever the ball intercepts a wall. Sound 2 is generated when a player successfully returns the ball. Sound 3 occurs whenever a point is scored.

3.4 Game Description - Target

The game of target is played with a rifle or pistol accessory containing a photocell detector circuit. The game of target causes a bright spot to appear on the screen. The player aims the rifle or pistol at the spot and depresses the trigger. If the shot is successful, a hit signal is generated by the photocell detector and both the shot and the hit are recorded. If the player misses, the shot is recorded.

Two variations of the target game are provided. The first causes a lit target to appear and move randomly around the display. The second variation causes a lit target to appear at different positions on the display for a duration of about 1.5 seconds. In either game, the player is permitted 15 shots. After each shot, a score display will appear showing the number of shots taken and the number of hits scored. A display of 12 06 is to be interpreted as six hits made for 12 shots taken.

Play begins with the depression of the Reset button. The initial score (00,00) appears on the screen. For automatic play, after an initial delay, the target will appear on the screen. Target motion or intermittent target flashes will continue to appear until a shot is fired. After each shot, the score will reappear to show shot and hit count. After another delay, the score will disappear and targets will again show on the display.

Firing and scoring continue until the 15th shot has been fired. The game is concluded and the final score remains on the screen until the next game is started.

The Manual mode operates in a similar manner except that the target will appear only in response to a depression of the Serve button.

Special logic is incorporated to prevent the recording of false hits due to room illumination, reflections, or deliberate aiming at light sources.

Targets will always appear as a bright spot on a dark background. There are no borders or boundaries presented on the display for the target games. Fig. 3.4 shows the display format for the target games.

Two sounds are generated during the operation of the target games. Sound 1 occurs whenever the target changes direction (as if it had reflected from a boundary). Sound 2 is generated each time the rifle or pistol trigger is depressed and a shot is recorded.

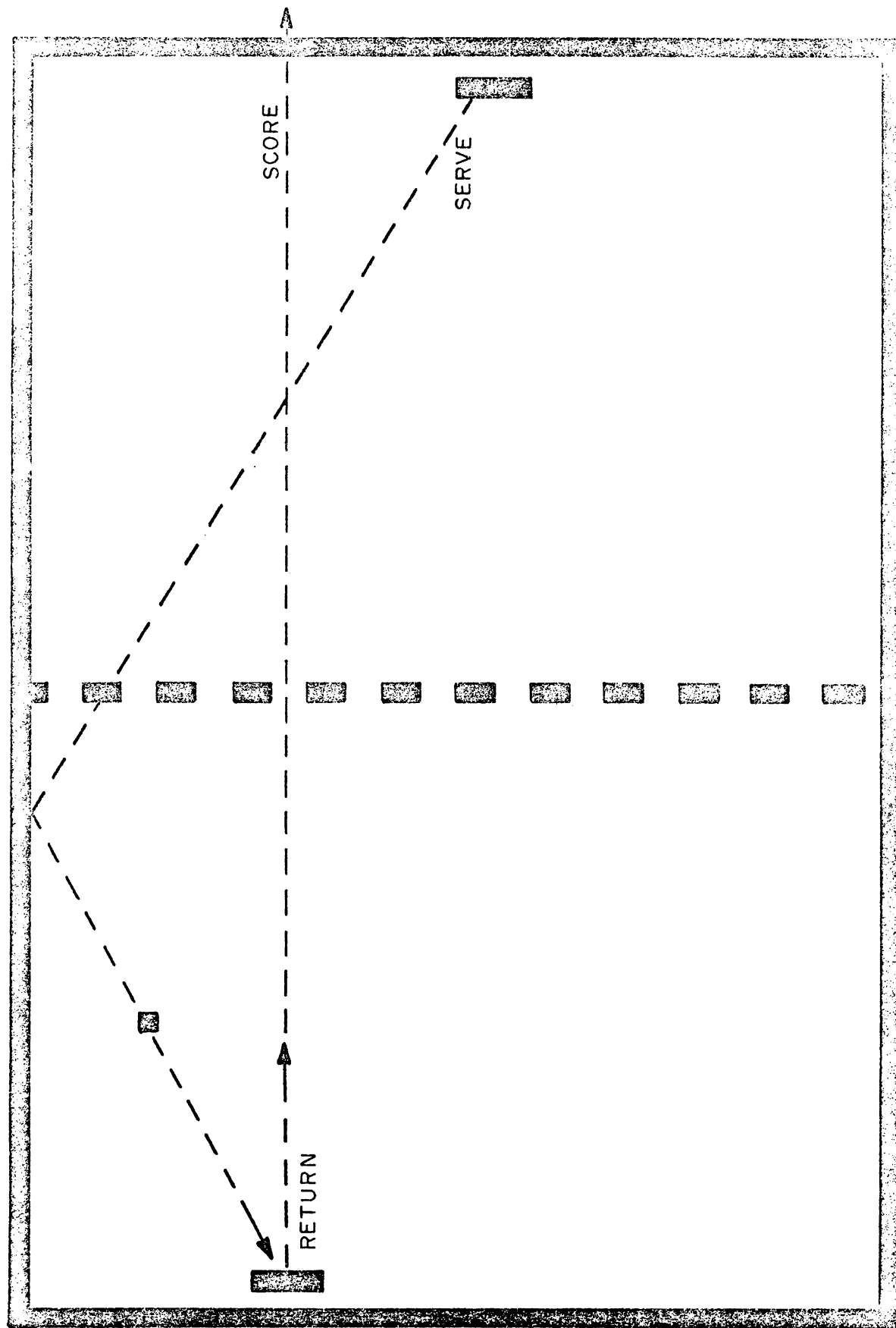


FIGURE 3.1A - 2 Player Tennis

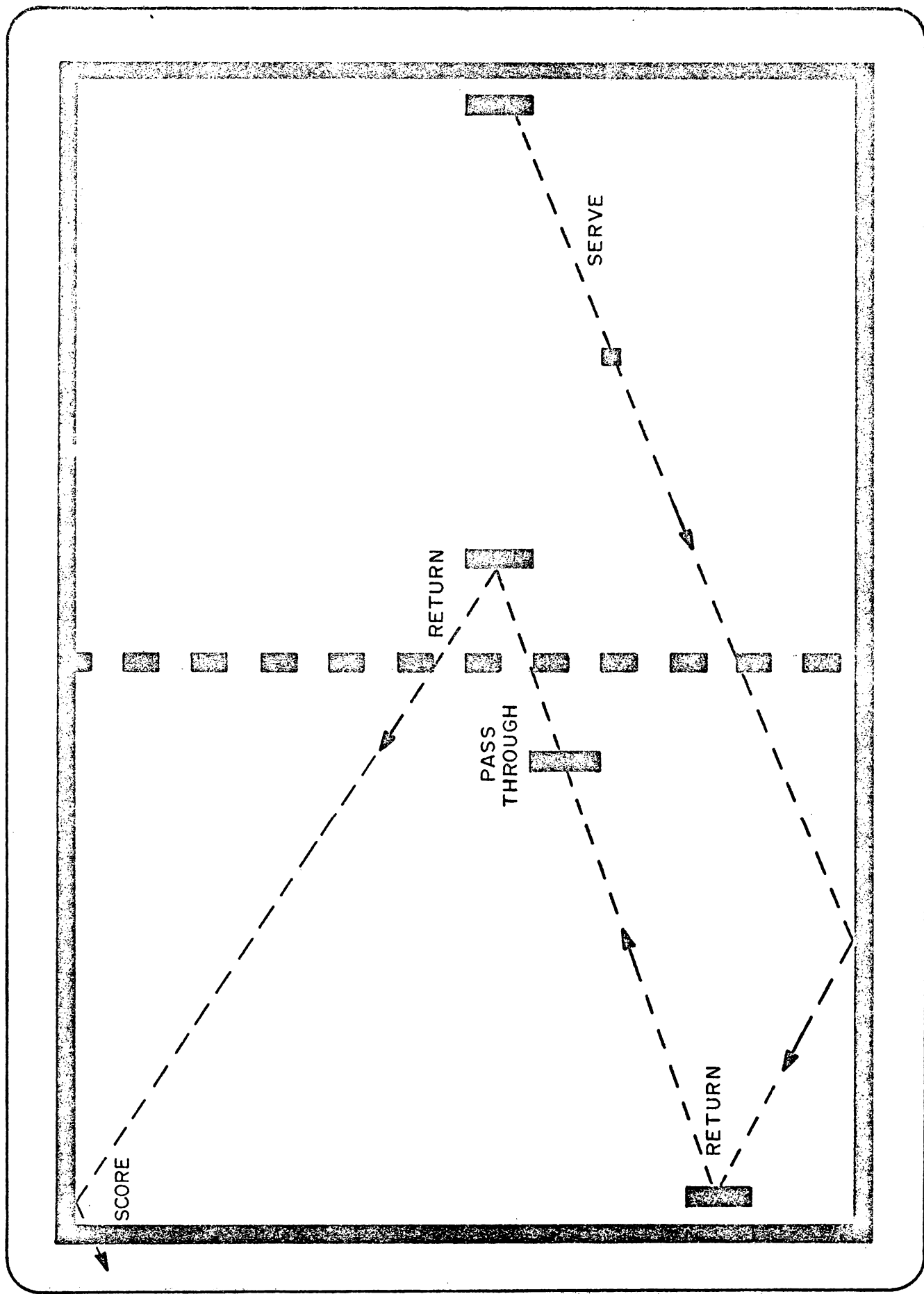


FIGURE 3.1B - 4 Player Tennis

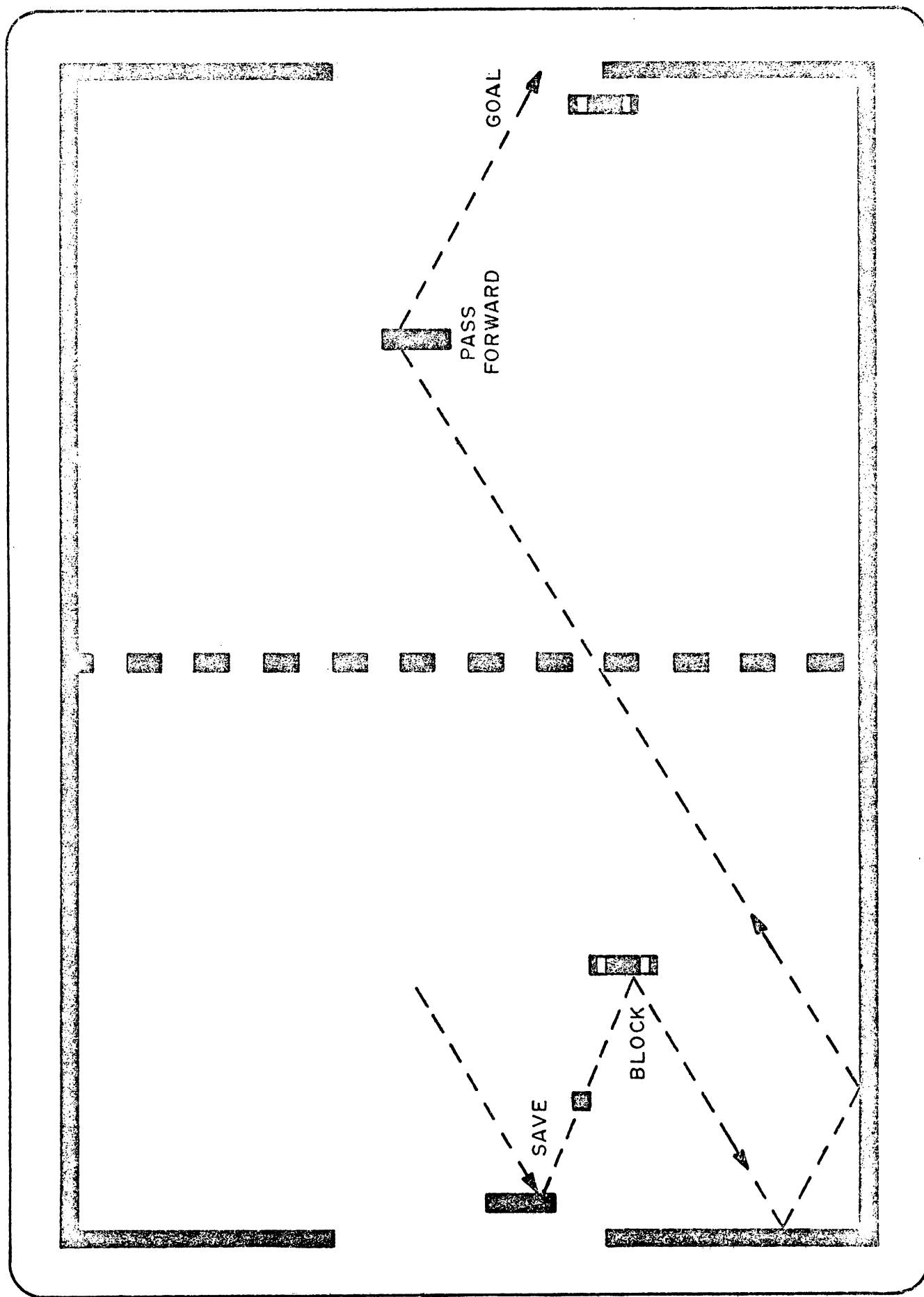


FIGURE 3.2 - HOCKEY (2 or 4 Player)

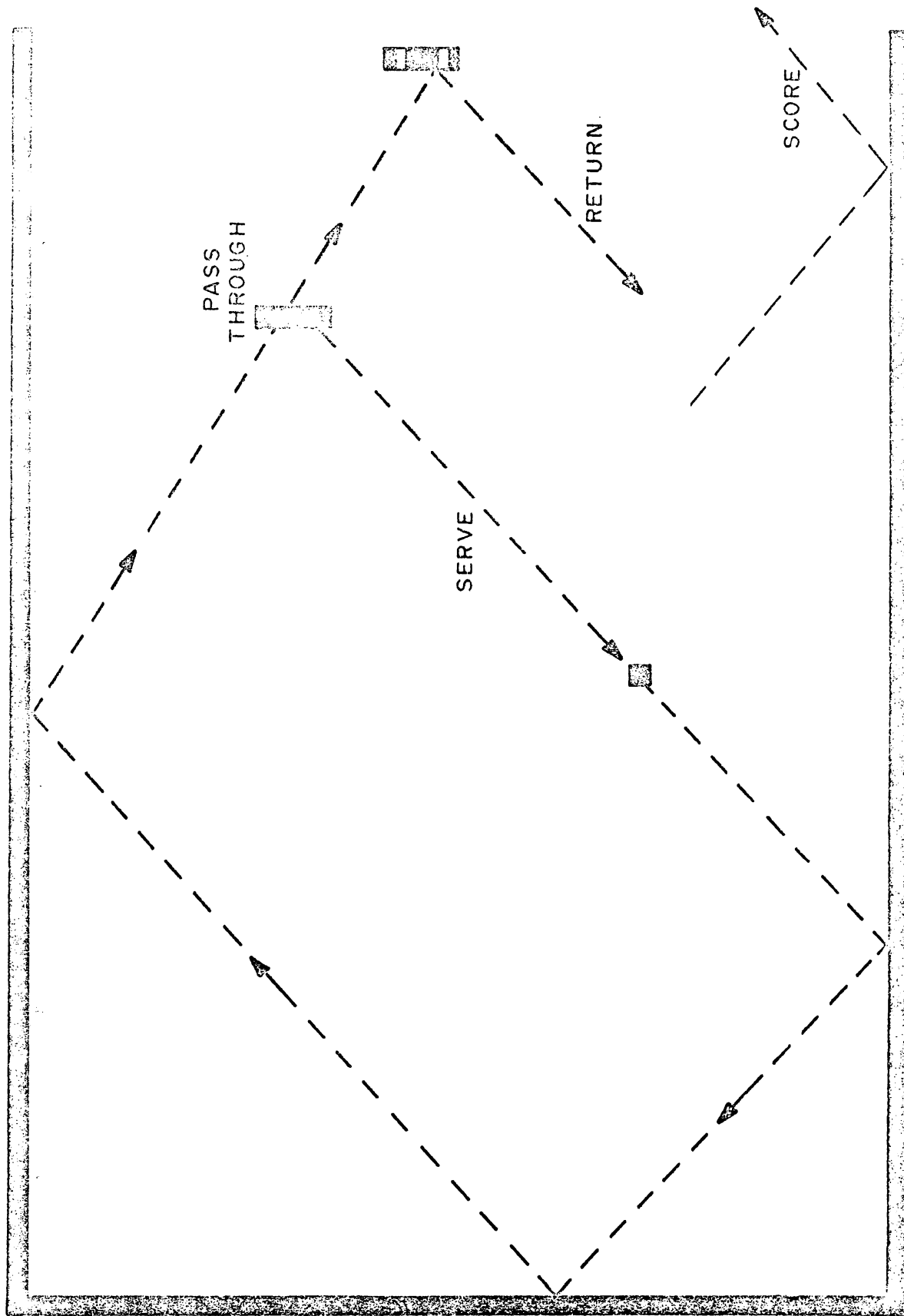


FIGURE 3.5A - HANDBALL - Two Player

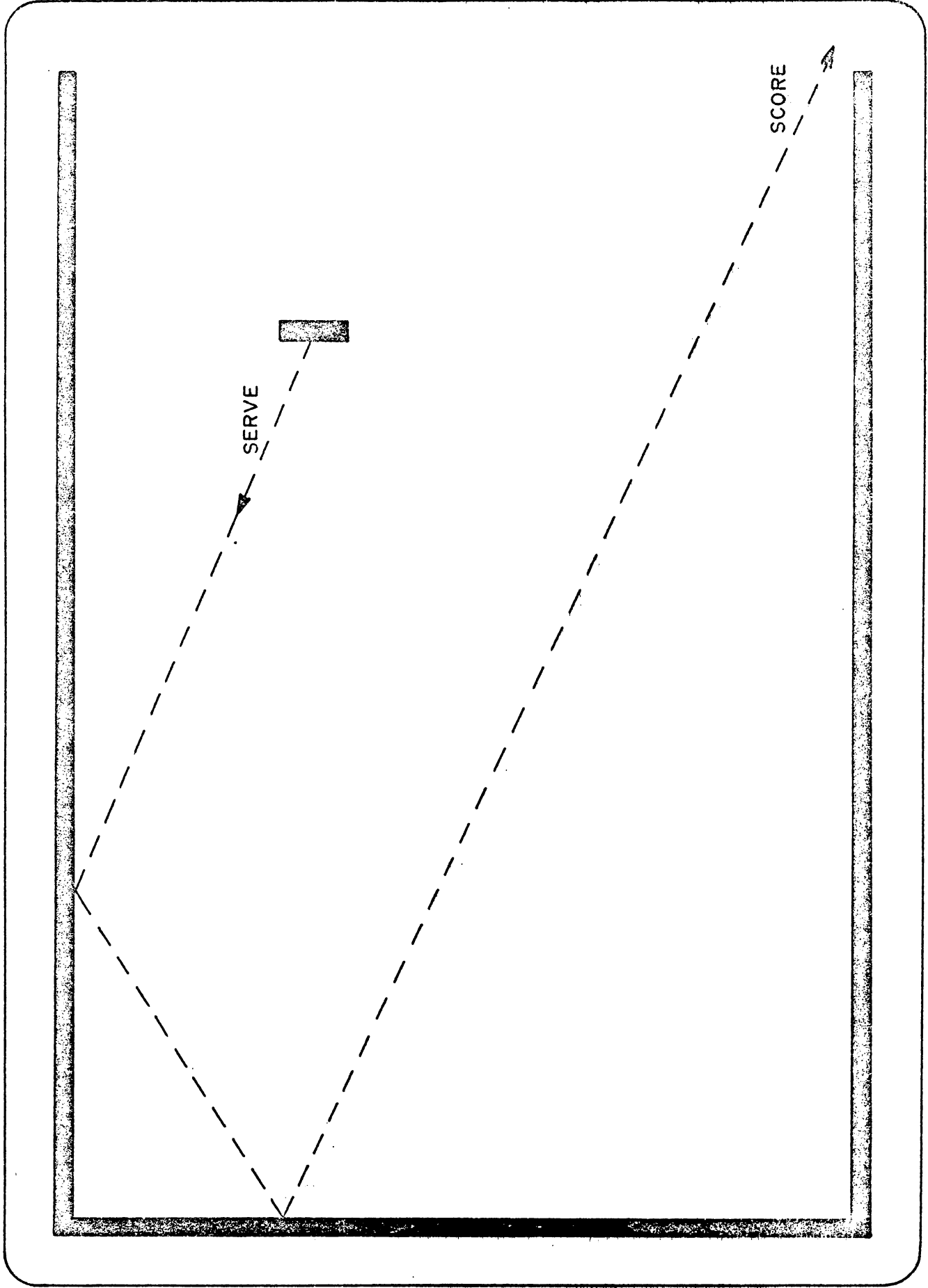


FIGURE 3.3B - HANDBALL - One Player

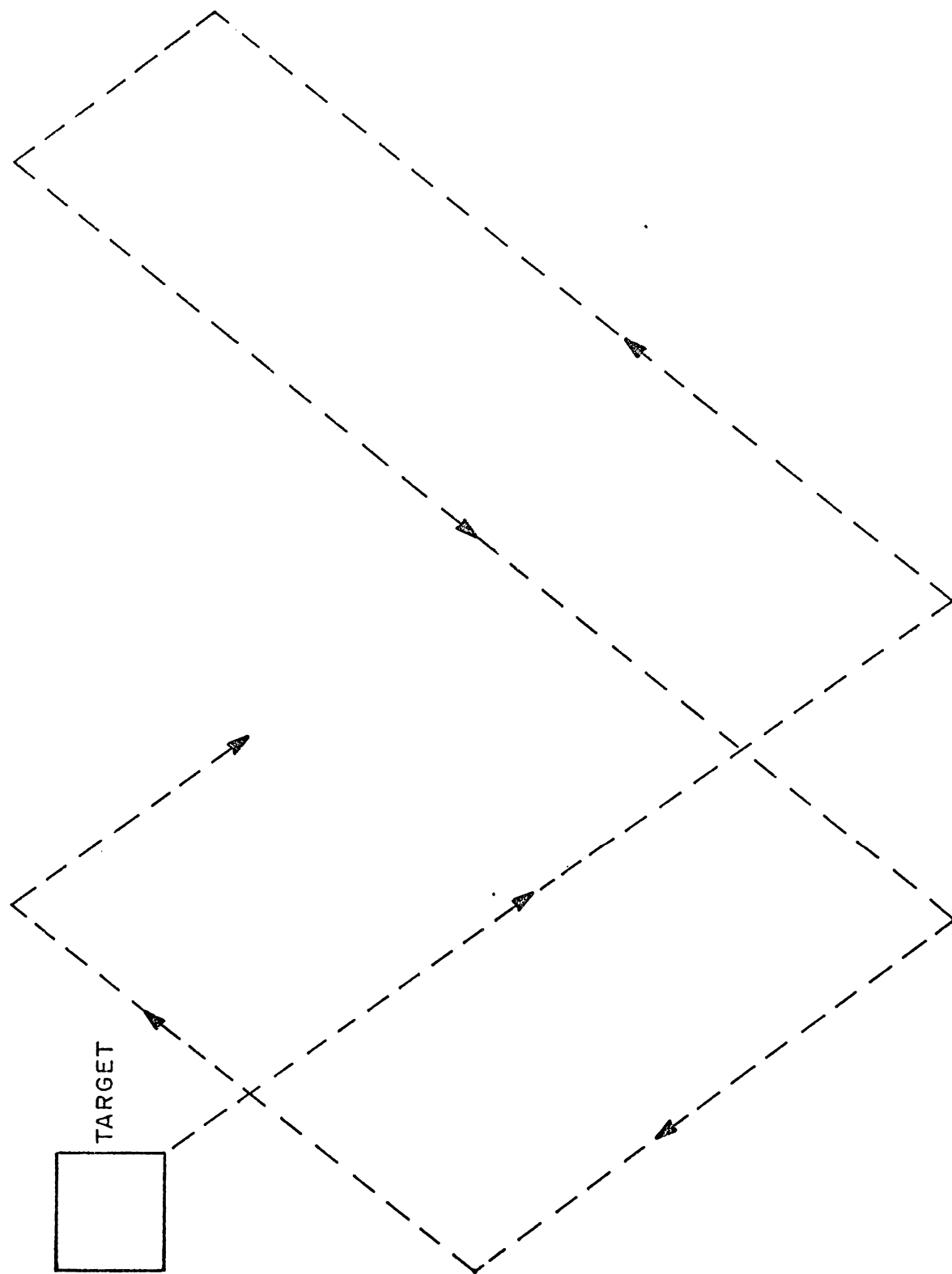
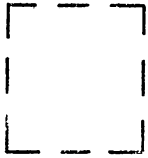
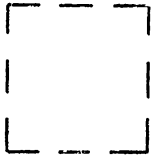
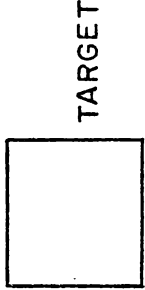


FIGURE 3.4A - TARGET - (Continuous)



TARGET APPEARS AT
RANDOM POSITIONS
FOR 1.5 SECONDS

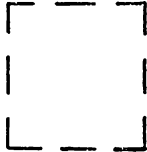


FIGURE 3.4B - TARGET - (Random)

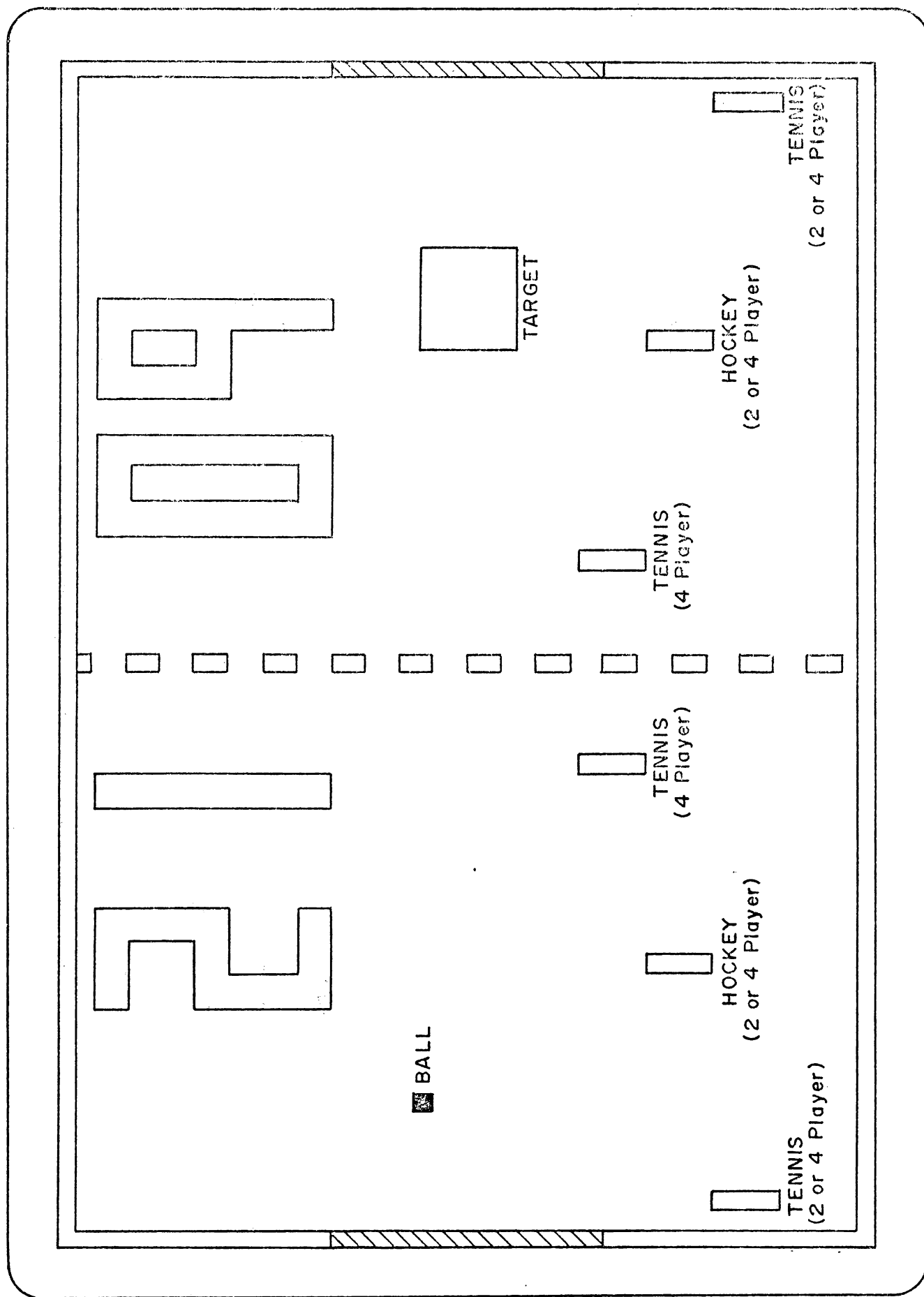


FIGURE 3.5 - PLAYER/SCORE POSITIONS

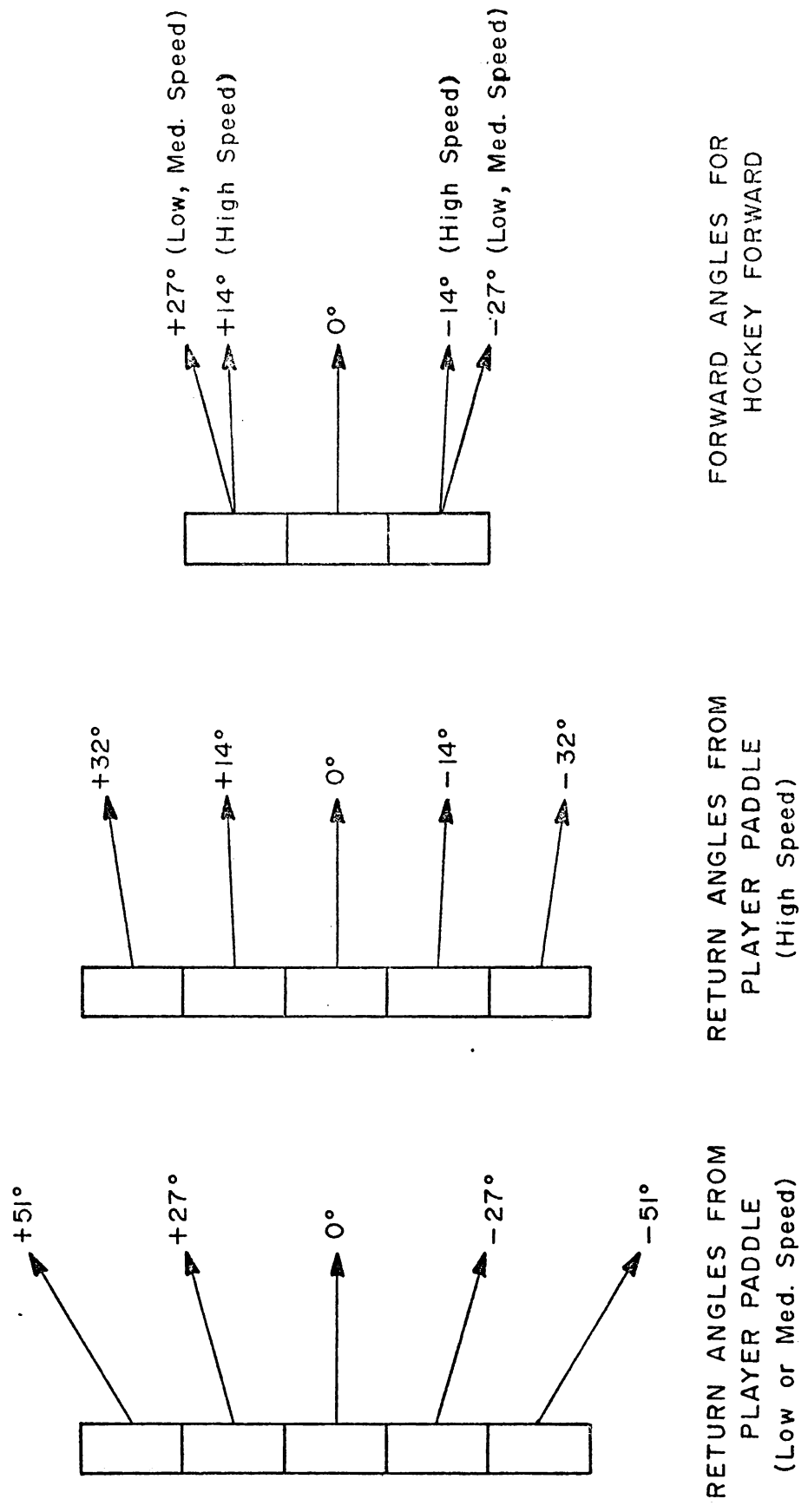


FIGURE 3.6 - RETURN AND FORWARD ANGLES

3.5 Game Controls

The controls for the MPS 7600-001 VGA include the following:

3.5.1 Game Selection

A four position rotary switch or four individual slide switches to define which of the four games is to be played (Tennis, Hockey, Handball, Target). If more than one switch is closed, the system will establish a priority based on the order: Tennis, Hockey, Handball, Target.

3.5.2 Game Variations

A single slide switch to define which of two variations of each game is to be played. The following table defines the variations:

<u>GAME</u>	<u>SWITCH OPEN</u>	<u>SWITCH CLOSED</u>
Tennis	2 Player	4 Player
Hockey	2 Player	4 Player
Handball	2 Player	1 Player
Target	Intermittant Target	Continuous Target

3.5.3 Reset Button

A momentary single pole switch is used to cause a system reset. The switch is depressed to start a new game or to discontinue a game in progress.

3.5.4 Automatic/Manual Switch

A slide switch which when open defines the automatic mode and when closed selects the manual mode.

3.5.5 Serve Button

A momentary single pole switch which becomes effective only when the Manual mode (See 3.5.4) is selected. Depression of this switch will cause the ball to be served or target motion to begin.

3.5.6 Amateur/Expert Switches

Two switches which when open allow the high speed ball motion (Expert position) or when closed (Amateur position) inhibit the high speed ball motion.

4.0 SYSTEM DESCRIPTION

The design of a complete video game using the MPS 7600-001 VGA involves the addition of several important circuits and components not included on the VGA. These elements include:

1. A power supply
2. A crystal for oscillator control
3. Player controls (4)
4. A sound generation circuit
5. An RF oscillator and modulator
6. A switch matrix for game control
7. A rifle/pistol for target games (if included)

4.1 System Block Diagrams

Fig. 4.1A shows all of the elements of a complete video game. All of the interface signals generated by or received by the VGA are shown. It should be noted that the designer may select from the various video signals generated to provide:

1. A black-and-white display only
2. A low cost color display (rainbow sweep)
3. A high quality color display with separate colors for individual game elements.

Fig. 4.1B shows a block diagram of the major functional elements of the VGA. The primary control element for the VGA is a frame processor with a 512 word ROM pre-programmed to manage each of the games included for a specific version of the VGA. The frame processor performs the specific tasks of:

1. Interrogation of the control switch matrix
2. Control of ball motion
3. Control of sound generation
4. Analysis of ball/boundary and ball/player intersections
5. Selection of game backgrounds
6. Computation and display of score

Shown separately from the frame processor are the logical elements for ball generation, background generation, player generation and motion control, and sound generation. Outputs from the appropriate logic blocks are combined to produce the various video signals required for the game. A further logic element combines background, player, and ball signals to record interactions of the ball with specific elements of the background or players.

A master oscillator and timing generator provides synchronizing and timing signals for all logic elements included in the VGA.

4.2 Clock Requirements

Fig. 4.2A shows the external components required for the generation of VGA clock signals. The VGA includes an oscillator circuit which is intended to operate in conjunction with an external crystal. The crystal frequency is selected by the designer depending upon what kind of color presentation is desired.

For a low cost color presentation, usually referred to as a "rainbow" sweep, the crystal frequency is set at 3.595314 MHz. This frequency is exactly one "line frequency" above the standard sub-carrier burst frequency for the NTSC color transmission standards.

For the high quality color presentation, the crystal frequency is set at 3.579545 MHz which is exactly the standard sub-carrier burst frequency for the NTSC color transmission standards.

In either case (and even if the designer wishes only a black-and-white presentation of the TV), the use of one of the crystals mentioned above is essential to the operational stability of the VGA.

4.3 Power Supply Requirements

The VGA operates from a single power supply within the range of -6.5 volts to -9.5 volts. Two pins on the VGA are connected to the negative potential (Vdd) and two pins are connected to the positive reference (Ground or Vss). The four pins reserved for the power supply connections must all be connected to insure stable operation of the VGA.

Most designs incorporating the VGA will be battery operated using the larger C or D size cells to insure adequate operating life for the game. An AC generated supply may be used but the designer must insure adequate current capacity and adequate filtering to eliminate sharp spikes on the supply lines. (The slow variation in voltage of a battery supply is not the same as the sharp transients generated by inadequate AC supplies. Such transients may result in perturbations of the game display.)

4.4 Player Controls

Each of the four player controls include a variable potentiometer and passive components shown in Fig. 4.4. Because the controls receive considerable abuse, the designer should select the best quality potentiometers available to guarantee smooth operation and long life.

Should the designer elect to eliminate any of the player controls, the pin intended for that control should be connected to Vss.

4.5 Sound Generation

Fig. 4.5 shows a typical low cost circuit for sound generation. The sound signal generated by the VGA is applied to a single transistor amplifier with a low cost 8Ω speaker driven directly in the emitter circuit.

4.6 Game Selection and Control

Fig. 4.6 shows a typical arrangement of the switches required for game selection and control of the MPS 7600-001 VGA. Note that the use of slide switches makes the use of isolating diodes mandatory for the configuration shown in Fig. 4.6A.

NOTE: Future games of the VGA series (MPS 7600-XXX) may make use of an expanded switch matrix as shown in Fig. 4.6B. Designers may wish to take account of this fact when producing printed circuit board layouts incorporating the VGA.

4.7 Video Signal Generation

A group of video signals are provided by the VGA. Not all of these signals will be used in a given design. Specifically, the signals generated include:

4.7.1 Composite Sync

This signal includes horizontal and vertical synchronizing pulses required to control the scanning circuits of a TV receiver. Each frame will include 262 lines. The frame rate will be close to 60 Hz. The composite sync signal must be used as one of the modulating signals for the RF oscillator regardless of the type of display selected by the designer.

4.7.2 Composite Video

This signal provides the required video signals for all elements of a game display on a line-by-line basis. Included in this signal are the video signals for the ball, background, and players. A combination of these signals and the composite sync signal (4.7.1) at the RF modulator would be adequate to present a black-and-white television presentation of the game.

4.7.3 Composite Color

This signal includes a color burst gate appearing at the "rear porch" of the horizontal sync signal and video gating signals for those elements of the game which are to appear in color. A combination of this signal together with the composite sync signal (4.7.1) and the composite video signal (4.7.2) at the RF modulator is sufficient to produce the low cost color presentation referred to as "rainbow sweep".

4.7.4 Individual Video Signals

These three signals are supplied to allow gating of the sub-carrier color frequency for the individual elements of the games. For the MPS 7600-001, the signals are defined as:

Video #1 - Player or Team A
Video #2 - Player or Team B
Video #3 - Ball, background, and score video

In concept, individual phase shifting circuits provide the desired phase shift of the color sub-carrier frequency. The individual video signals (#1, #2, #3) are used to gate the outputs of the phase shifting circuits to the RF modulator.

4.8 RF Signal Generation

Figure 4.8 shows the use of the various video signals for different forms of RF modulation to produce the various game presentations.

Figure 4.8A shows the combination of the composite video and composite sync signals to produce an RF signal for a black-and-white display.

Figure 4.8B shows the combination of the composite sync, composite video, and composite color signals to produce a "rainbow sweep" color display.

Figure 4.8C shows the combination of the composite sync, and individual color video signals (#1, #2, #3) to produce the high quality color display.

4.9 Target Game Interface

The target games included on the MPS 7600-001 VGA require the use of an accessory rifle or pistol. Such a device must provide a switch closure which closes in response to an operation of the trigger. This switch is connected to the control matrix as shown in Fig. 4.4.

In addition, the rifle or pistol must include a photoelectric detection circuit. The output of this circuit will generate pulses which are received at the VGA on the pin labelled HIT.

Fig. 4.9 shows the connections of the rifle or pistol to the VGA.

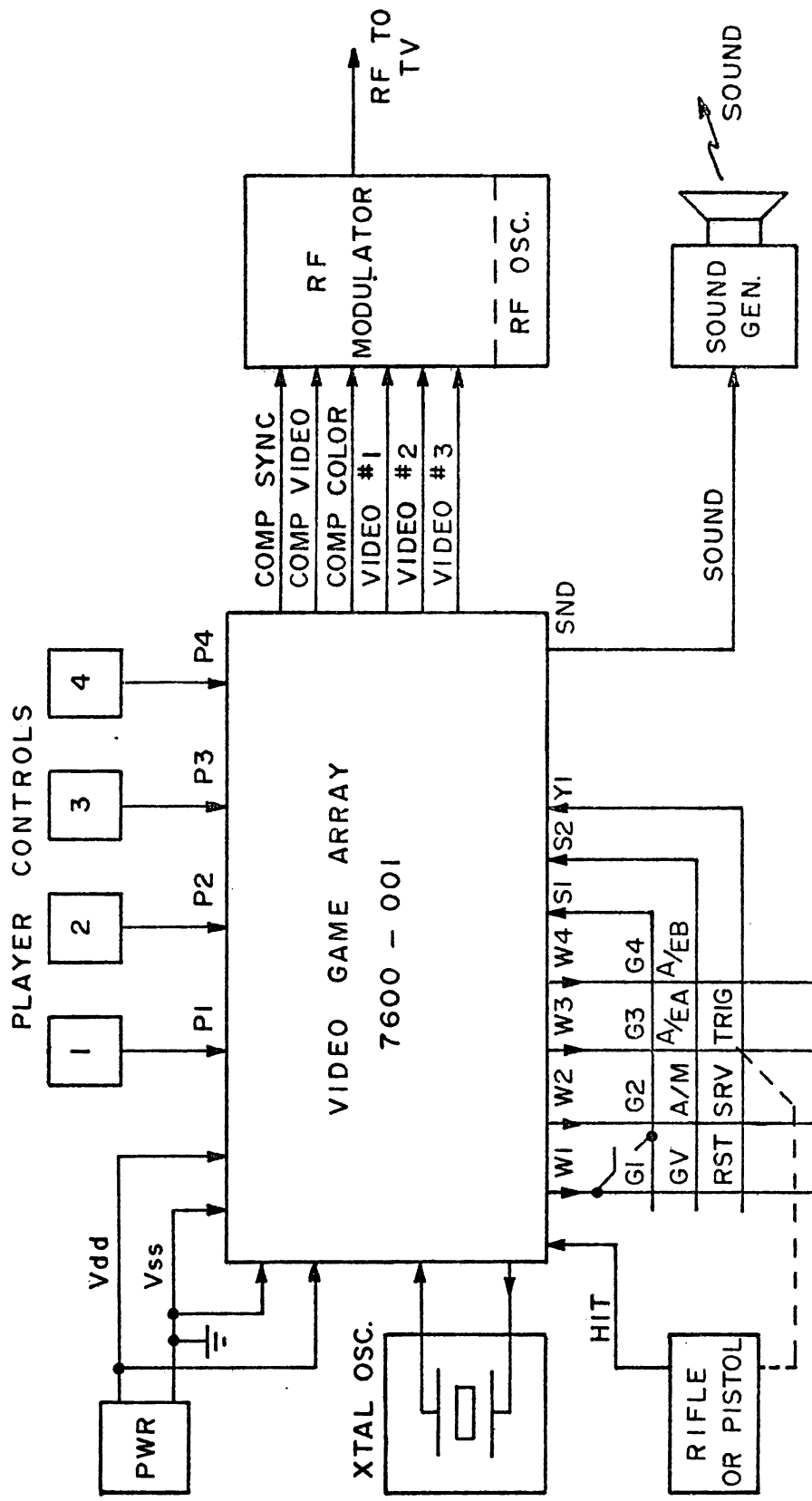


FIGURE 4.1A VGA SYSTEM BLOCK DIAGRAM

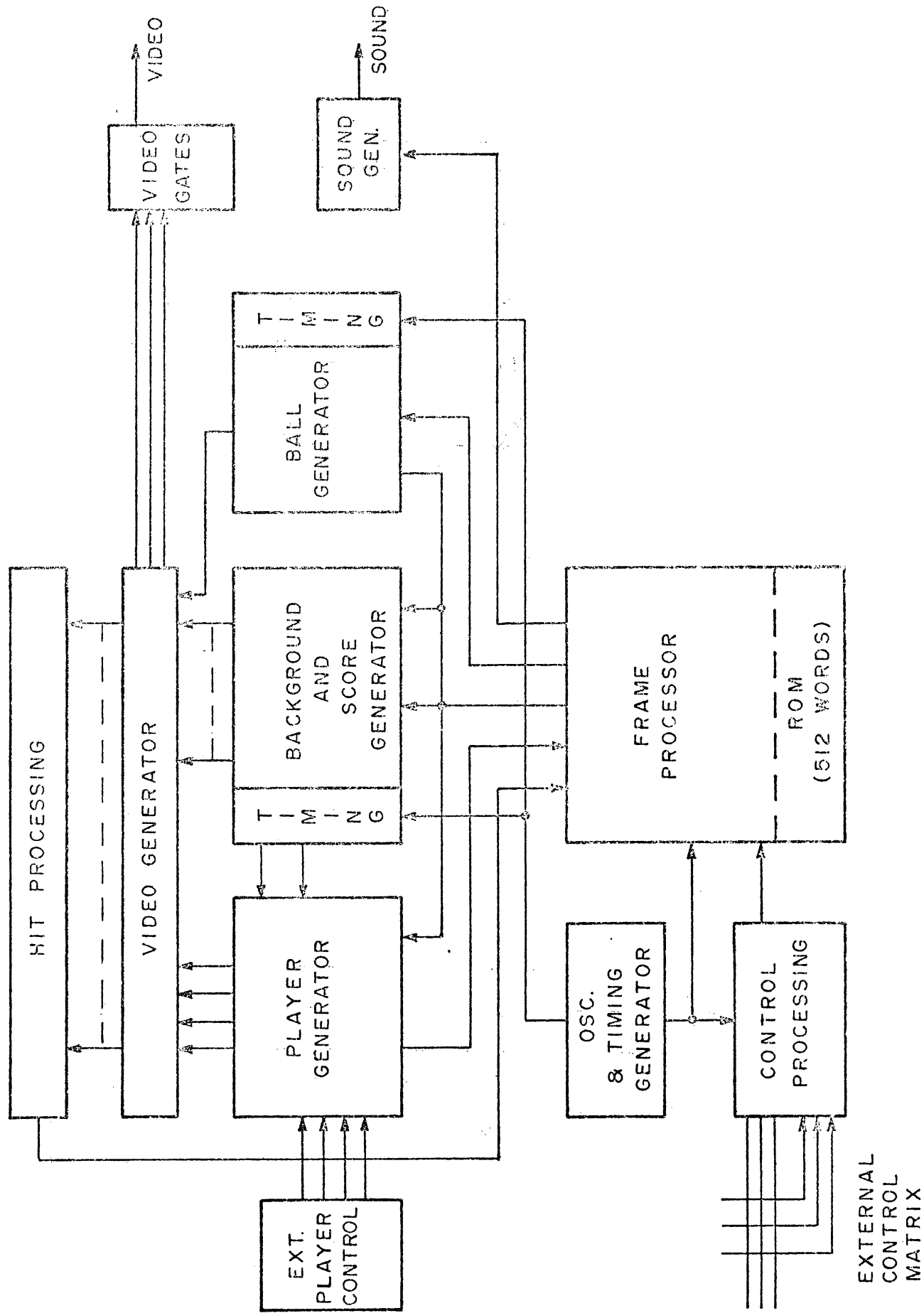


FIGURE 4.1B VGA BLOCK DIAGRAM

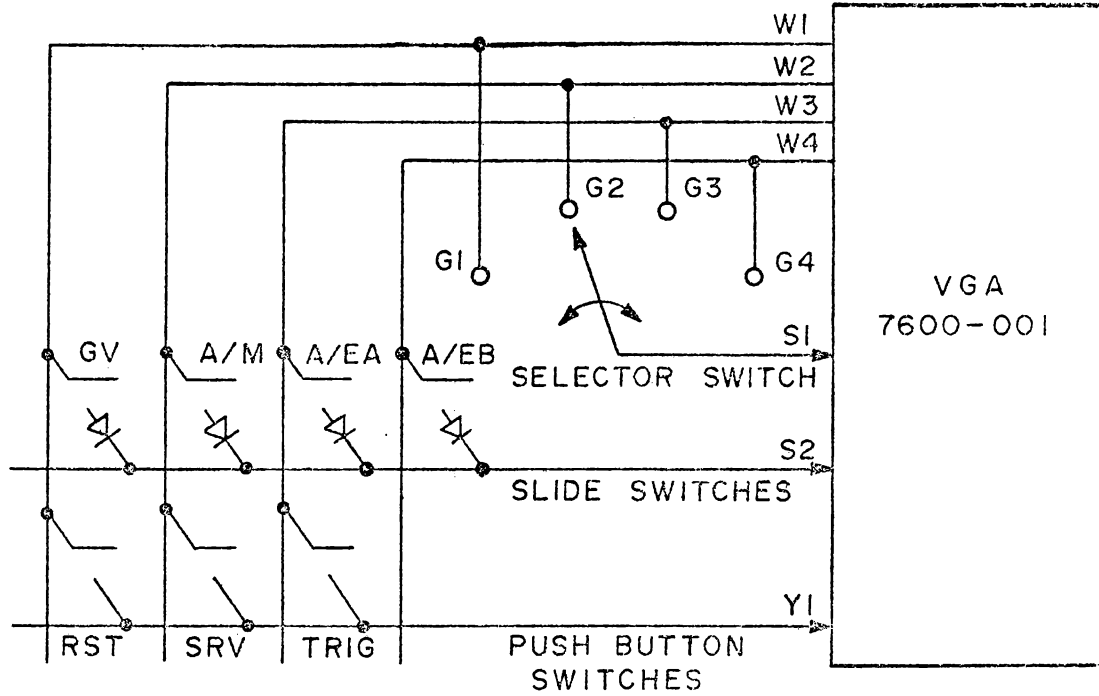


FIGURE 4.6A - Control Matrix (VGA 7600-001)

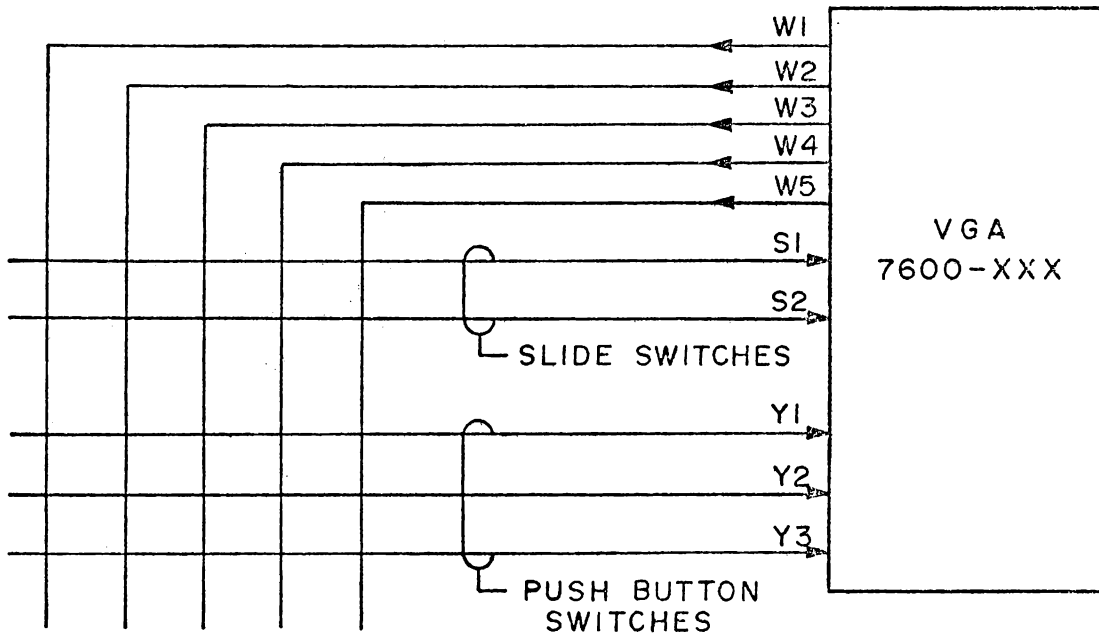


FIGURE 4.6B - General Control Matrix (VGA 7600-XXX)

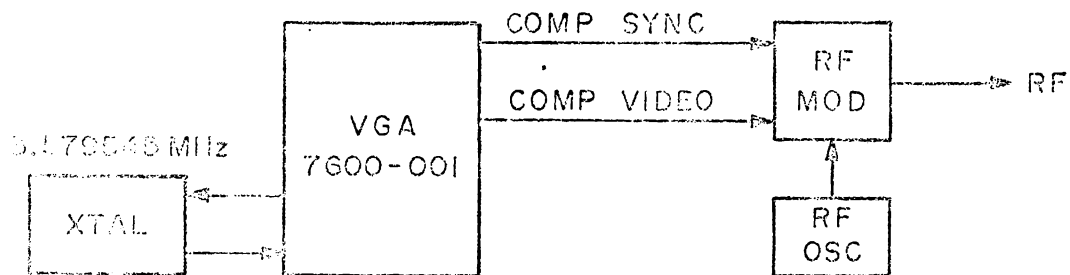


FIGURE 4.8A - Black-and-White TV Display

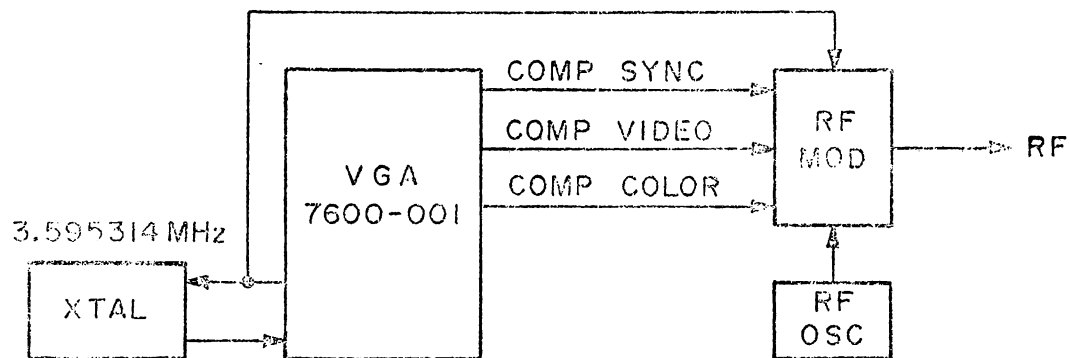


FIGURE 4.8B - Color TV Display (Rainbow Sweep)

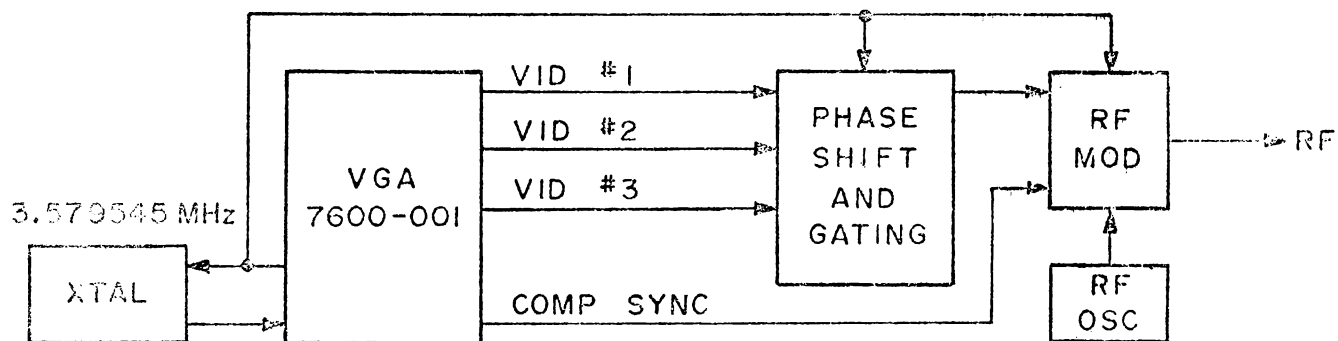


FIGURE 4.8C - Color TV Display (Full Color Control)

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